

REMARKS

This responds to the Office Action dated June 15, 2006, and the references cited therewith.

No claims are amended, no claims are canceled, and no claims are added; as a result, claims 1-44 are now pending in this application.

Applicant's Reply to Prior Art Arguments – Rejections

In the Applicant's response dated April 19, 2006, claim 1 was amended so that the recited method “reduce[d] power consumption during execution of the code while satisfying user-specified real time performance constraints on a microprocessor.” In response, the Office Action of June 15, 2006 on page 3 states that the specification states that the “user-specified real time constraints can include constraints such as the number of power down instructions that can be inserted into an execution path, the number of additional cycles of execution time the user is willing to incur, and other such constraints.” The Office Action further states that the claimed performance constraints reduce power by constraining execution instructions, execution time, and other such constraints.

The Office Action goes on to state that Bartley discloses that in “the case of either a compiler or an assembler, an optimizing process finds, for each functional unit, program segments during which the functional unit is not used. Once these segments are found, the compiler then inserts a power-modifying instruction at the point in the code when the functional unit first goes out of use.” The Office Action then concludes that this section of Bartley teaches modifying code depending on time constraints to reduce power consumption, and further concludes that Bartley's teaching of a time threshold would have been sufficient motivation to one of skill in the art, at the time that the invention was made, to consider execution time in relation to instructions to save power. The Applicant respectfully traverses this contention.

There is a distinct difference between Bartley and claim 1. Bartley relates to identifying program segments of a processor during which a functional unit of a processor is not used. Bartley then determines whether it is worthwhile to place a power down instruction into the code based on the duration of time that the functional unit is not used. The user-specified number of additional cycles of execution time of pending claim 1 relates to the extra execution time of the

processor caused by the addition of the power down instructions. There is very little relation between Bartley's time period that a functional unit is *not* used, and the number of processor cycles *added* by power down instructions. Therefore, the Final Office Action's statement that Bartley's teaching of a time threshold (the duration that a functional unit is not being used) serves as a motivation for someone adding power down instructions to code to consider the additional execution cycles of the power down code is a *non-sequitur*, and fails to establish a *prima facie* case of obviousness.

A further distinction includes the lack of concern in Bartley for real time performance of the executing code. The claims clearly indicate reduction of power consumption while satisfying real time performance constraints related to execution of the code. Bartley uses a threshold to determine whether sufficient power would be saved, not whether performance of code constraints are met.

Independent claims 14, 24, and 34 recite the "user-specified real time performance constraints" as claim 1 does, and likewise the Final Office Action fails to establish a *prima facie* case of obviousness regarding those claims.

For the sake of completeness, the Applicant reiterates below its prior arguments to the rejection of the claims by the Patent Office.

§103 Rejection of the Claims

Claims 1, 2, 11-15, 22-25, 32-36, 43 and 44 were rejected under 35 USC § 103(a) as being unpatentable over Bartley (U.S. Patent No. 6,219,796) in view of Y. Li et al. (A framework for estimating and minimizing energy dissipation of embedded hw/sw systems). This rejection is respectfully traversed.

The present claims allow a tradeoff between performance, and power conservation based on user specified constraints for execution of program code. The references used to reject the claims either focus entirely on efficient use of power, or selection of hardware sizes to accomplish performance and energy usage goals. Neither reference, alone or combined, teach or suggest the use of power down instructions in code to reduce power consumption while satisfying user specified performance constraints.

The claims clearly point out reducing power consumption during the execution of the code while satisfying user-specified performance constraints and clearly point out the difference between the claimed invention and the cited references.

The references will now be discussed in further detail to more clearly point out the differences between the references, alone or combined, and the claims.

Bartley describes scanning of code to determine that a functional unit of a processor will not be used during execution of a program. That functional unit is then shut down to conserve power. Instructions may be inserted to turn such functional units off and on. Thresholds may be used to make sure that at least some benefit is provided by doing so. As noted several times in Col. 7, Bartley focuses on ensuring efficient use of power. Lines 17-18, and 38. The entire context of Col. 7 is to efficiently use power. Despite references to static and dynamic program analysis, and thresholds, they all relate to identifying sections of code where a shutdown may occur to efficiently use power, and do not relate to code performance. No mention is made of code performance in Bartley, only efficient use of power.

Y. Li et al. is used to modify hardware, such as cache and main memory size to trade off performance and energy use goals. It has nothing to do with inserting power down instructions in code. It is a very inflexible application of power conservation techniques to a dedicated hardware platform. Once done, it is optimized to an individual application. Thus, it teaches away from the ability, or even any desire to use power control instructions in programs. Neither reference, alone or combined teaches or suggests inserting power down instructions to reduce power consumption while satisfying user-specified real-time constraints.

The Office Action states that Bartley does not disclose "...satisfying user-specified real-time constraints.", but then indicates that Li et al., discloses "...satisfying user-specified real-time constraints...". The Office Action then indicates that it would be obvious to combine Bartley and Li et al. Applicant does not believe that the references are properly combinable, as each is directed to very different aspects of power reduction.

Bartley inserts power-down instructions into programming with the goal of reducing power consumption. Li et al., describes a very different type of system. In Li et al., an embedded system is described, where the software and hardware components are designed and modified with power conservation in mind. Software may be transformed, and different sizes of

cache and main memory are considered to optimize power conservation. In that process, which is very different from the power down aspects of the present application and Bartley, there is no consideration of powering down different components. Rather, the components themselves may be modified in size to conserve power.

As can be seen, the approaches of Li et al. versus those of the present application and Bartley are very different. While both may be directed to improving energy consumption, there is nothing in Bartley and Li et al. that indicate different aspects of them may be combined. The Office Action first indicates that the motivation to combine them comes from Bartley, "as he refers to program segments having a duration longer than a "predetermined threshold." (Column 7, lines 42-43) , wherein it is obvious the threshold may be determined by a user either via a user selected algorithm or other user input." The purported motivation is in the context of finding code segments of long enough duration to make it worth shutting down a functional unit. If it would take longer than the amount of time required for execution of the segment to turn it off and then turn it back on, it would not make sense to turn it off in the first place. "Various power modeling techniques can be used to determine the length of time during which it is more efficient to turn a component off (or partially off) then on again versus leaving it on." Col. 7, lines 16-19. It does not relate directly to satisfying user-specified real time constraints or program performance as currently claimed. As such, it would not suggest to one of skill in the art that performance optimization goals should be considered. In practice, with the presently claimed invention, there may be many places in code where a power down instruction could be added. The claimed invention allows one to determine where to put them to optimize power consumption within user specified constraints.

The Office Action also indicated that Li et al. disclosed "...satisfying user-specified real-time constraints..." It should be noted that Li et al., describes different optimization goals in the context of changing sizes of cache and main memory, not in the context of powering down different functional units. This great difference in architecture and methodology of conserving power makes it highly unlikely that Li et al., would be considered by one of skill in the art when focusing on powering down different functional units.

Independent claims 14, 24, and 34 all contain similar recitations and distinguish the references for at least the same reasons.

The Office Action further states that Bartley discloses that segments would be of longer duration than some predetermined threshold, and indicates that the threshold **inherently** must be predetermined or user specified. This statement is respectfully traversed, as it is based on inherency. The Office Action has not established a *prima facie* case of inherency because, as recited in MPEP § 2112, “In relying upon the theory of inherency, the examiner must provide basis in fact and/or technical reasoning to reasonably support the determination that the allegedly inherent characteristic necessarily flows from the teachings of the applied prior art,” citing Ex parte Levy, 17 USPQ2d 1461, 1464 (Bd. Pat. App. & Inter. 1990) (emphasis in original).

The Office Action only argued that a “the threshold inherently must be predetermined or user specified.” It should be noted that this statement in itself provides an alternative way of determining the threshold other than user specified. As such, it shows that the result does not necessarily flow from the cited language, and the rejection is improper.

Further, as the time threshold is related to determining whether there would be any benefit obtained by powering down, it is clearly not a user specified real-time constraint. The Office Action does not even assert that the allegedly inherent characteristic is necessary, let alone provide a basis in fact and/or technical reasoning. Applicant respectfully submits that the threshold of Bartley is determined in the following manner, which is clearly not user specified: “Various power modeling techniques can be used to determine the length of time during which it is more efficient to turn a component off (or partially off) then on again versus leaving it on.” Col. 7, lines 16-19. Each threshold appears to be fixed and based on efficiency, not user specified time constraints. Thus, the claim language of inserting power-down instructions while satisfying user-specified real-time constraints does not necessarily flow from the cited language of Bartley, and the rejection should be withdrawn, as at least one element of the claims is lacking from the combination even if proper.

In practice, with the presently claimed invention, there may be many places in code where a power down instruction could be added. The claimed invention allows one to determine where to put them to optimize power consumption within user specified constraints, to make sure that the overall program performance is as desired. Neither reference, alone or combined provides this capability.

Li et al. does not provide power down instructions, but instead changes sizes of caches and main memory to obtain user specified performance and energy use goals. The Office Action indicated that Li et al. disclosed "...satisfying user-specified real-time constraints..." It should be noted that Li et al., describes different optimization goals in the context of changing sizes of cache and main memory, not in the context of powering down different functional units. Thus, it is not proper to ascribe the performance constraints in this context with the insertion of power conservation instructions. One relates to hardware design, and the other relates to programming existing hardware. This great difference in architecture and methodology of conserving power makes it highly unlikely that Li et al., would be considered by one of skill in the art when focusing on powering down different functional units. It also places the likelihood of success of such a combination in great jeopardy.

Finally, Applicant believes that the prior amendments to the claims overcome all the prior rejections of the claims, and reserves the right provide arguments to such rejections should they be repeated in subsequent actions.

Claims 3-10, 16-21, 26-31 and 37-42 were rejected under 35 USC § 103(a) as being unpatentable over Bartley (U.S. Patent No. 6,219,796) in view of Y. Li et al. and further in view of G. Ramalingam (Data Flow Frequency Analysis, SIGPLAN Conference on Programming Language Design and Implementation, 1996). This rejection is respectfully traversed, as all depend from independent claims that are believed allowable.

CONCLUSION

Applicant respectfully submits that the claims are in condition for allowance, and notification to that effect is earnestly requested. The Examiner is invited to telephone Applicant's attorney at (612) 373-6972 to facilitate prosecution of this application.

If necessary, please charge any additional fees or credit overpayment to Deposit Account No. 19-0743.

Respectfully submitted,

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CERTIFICATE UNDER 37 CFR 1.8: The undersigned hereby certifies that this correspondence is being filed using the USPTO's electronic filing system EFS-Web, and is addressed to: Mail Stop Amendment, Commissioner of Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on this 16 day of Oct 2006.

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